NASA Science Mission Directorate
Earth Science Division
Applied Sciences Program

Land Surface and Hydrology Applications at the NASA SPoRT Center

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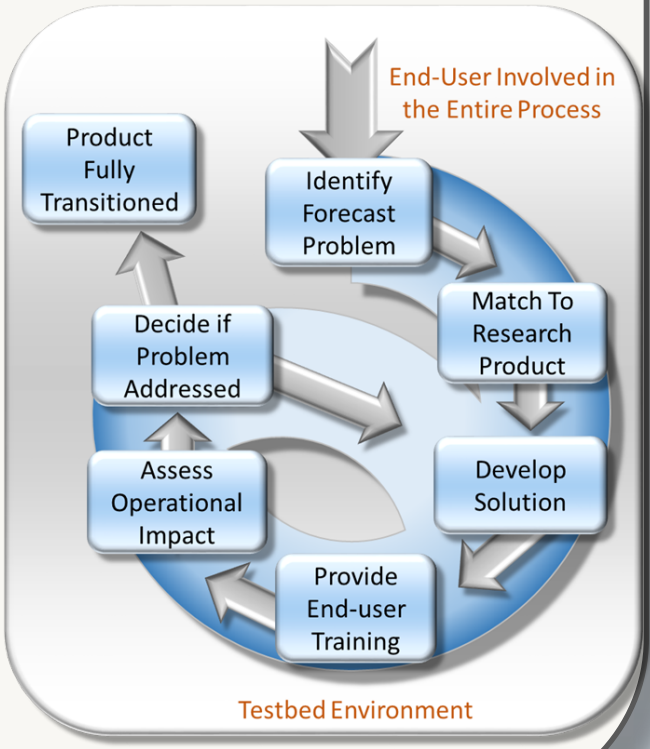
NASA Water Resources PI Meeting

April 26-28, 2016

Short-term Prediction Research and Transition (SPoRT) Center

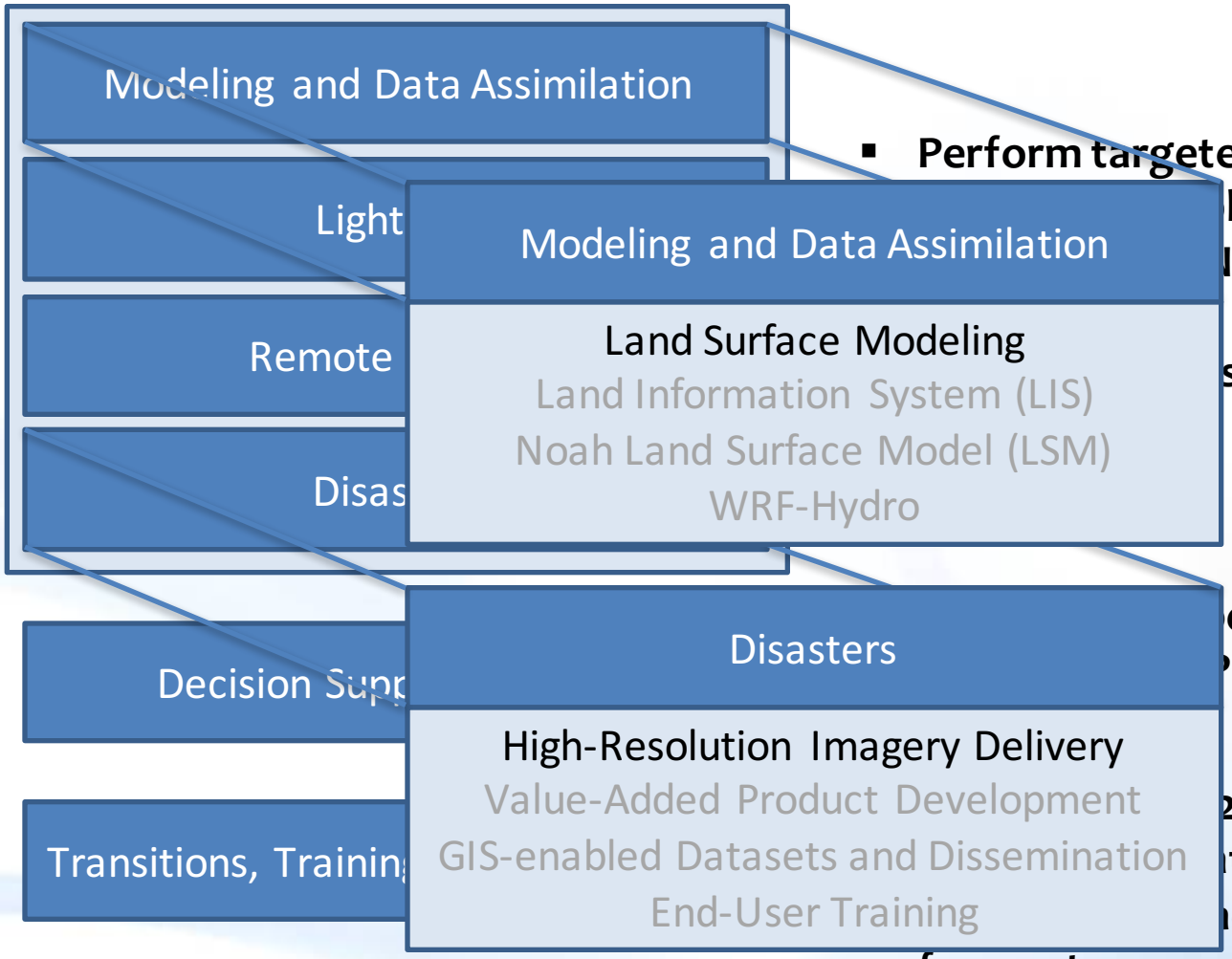
- **SPoRT is focused on transitioning <u>unique</u> NASA observations and research capabilities to the operational weather community to improve short-term weather forecasts on a regional and local scale.**
- **Use experimental modeling systems that are modeled after operational systems**
- **Proven paradigm for transition of research and experimental data to "operations"**



<u>Benefits</u>

- demonstrate capability of NASA experimental products for operations, applications, and societal benefit
- prepares forecasters and modeling systems for use of data from next generation of operational (e.g., JPSS, GOES-R)

SPoRT Areas of Expertise



- Perform targeted research
  loit unique
  NASA satellites and
  solve specific
  sting challenges

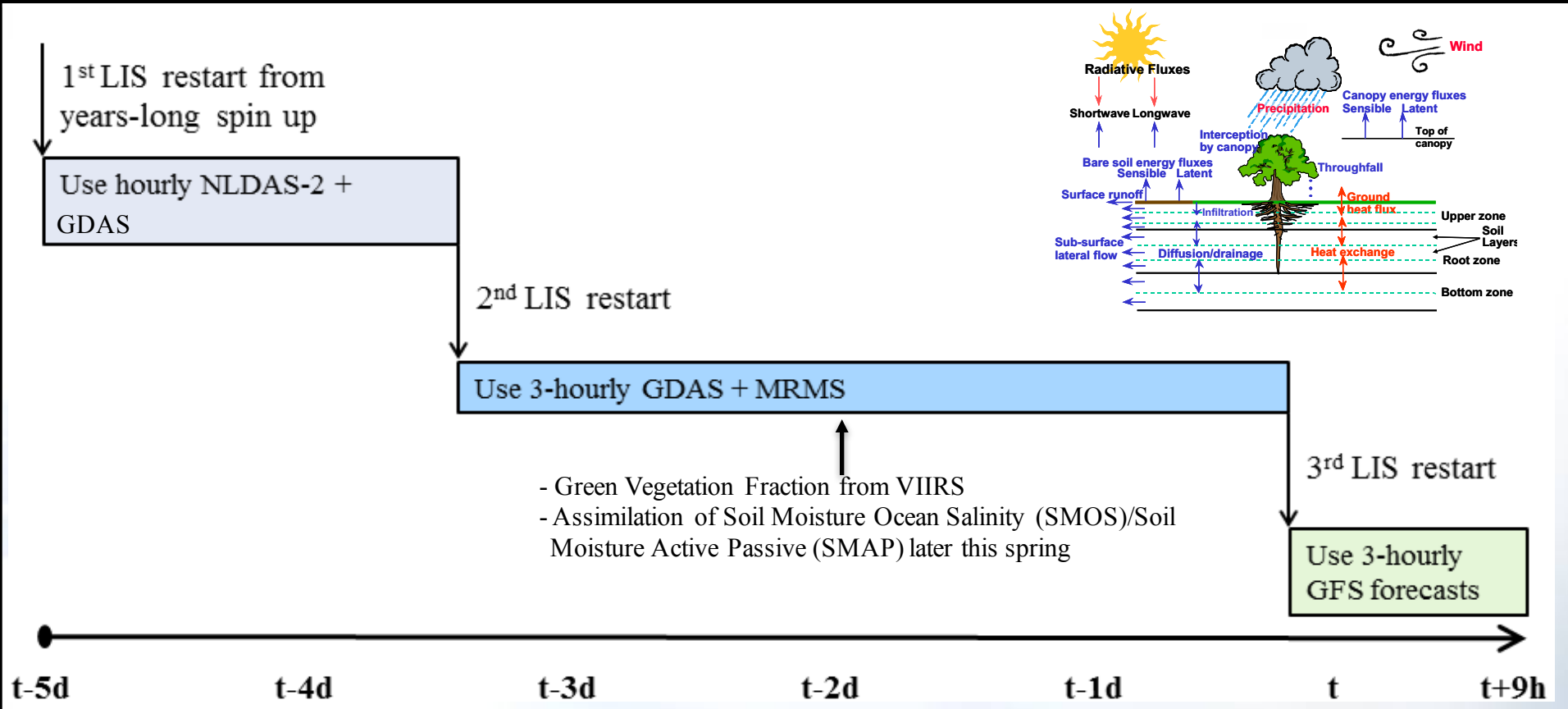
  duct dissemination
  S II, N-AWIPS, WMS,

  2O/O2R paradigm for
  ta and obtaining
  ck from NWS
  forecasters

NASA Connections to National Water Model

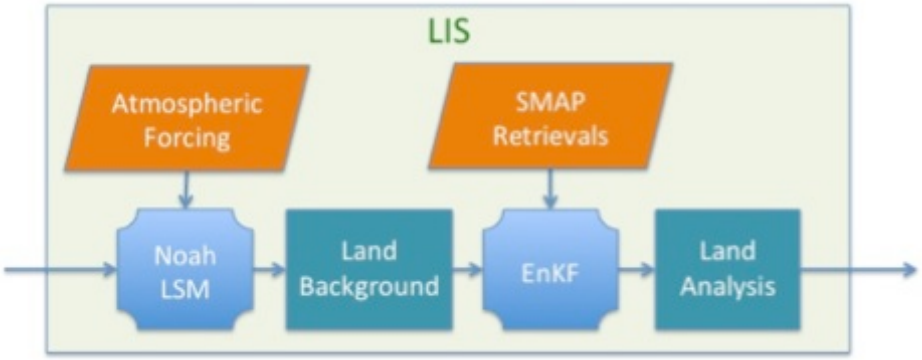
- NOAA/NWS Director Louis Uccellini expressed a desire to include NASA datasets to aid the National Water Model (NWM; an operational version of WRF-Hydro) during a Hydrology Program Managers Meeting in May 2015
- As of earlier this year, the NWC does not have a specific strategy for assimilation of satellite observations into the NWM
- LIS output can be used to initialize WRF-Hydro runs; LIS contains an Ensemble Kalman Filter that could be used for assimilating land surface data
- Joe Santenello (GSFC) is funded through a NASA ROSES15 Modeling, Analysis, and Prediction (MAP) proposal with Dave Gochis (NCAR) to develop a code infrastructure to fuse LIS with WRF-Hydro; SPoRT will be helping with some science cases to demonstrate impacts
- Through this linking, it will be possible to integrate and assimilate NASA satellite observations to improve the initialization of land surface conditions for WRF-Hydro
- SPoRT is developing an offline configuration of the National Water Model that will support R2O collaborative activities

Operational SPoRT LIS



- **NASA LIS used to perform long-term integration of Noah Land Surface Model**
  - High spatial resolution (3-km over CONUS) to capture sub-county soil features
  - MRMS precipitation allows for high resolution rainfall up to real-time
  - Forecast precipitation makes product available for nowcasting

LIS Ensemble Kalman Filter (EnKF)



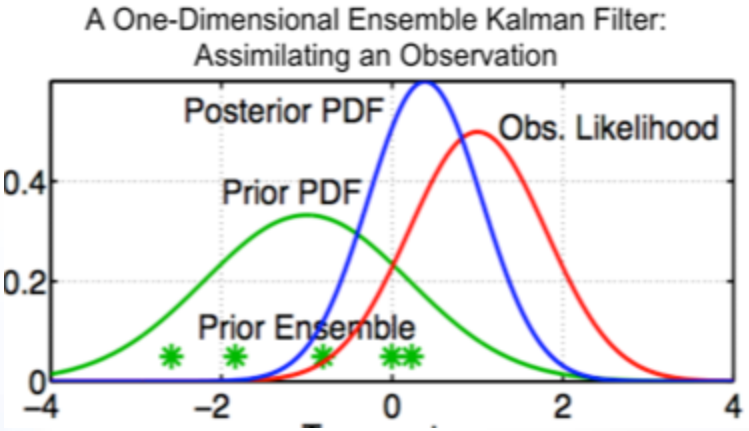
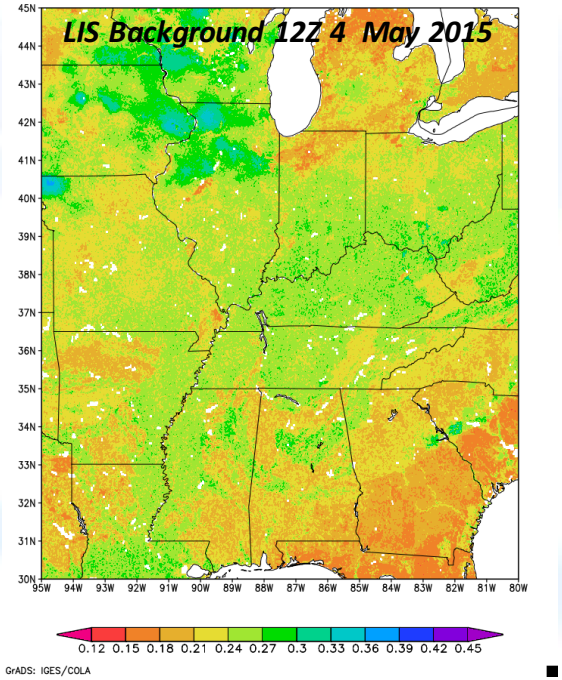


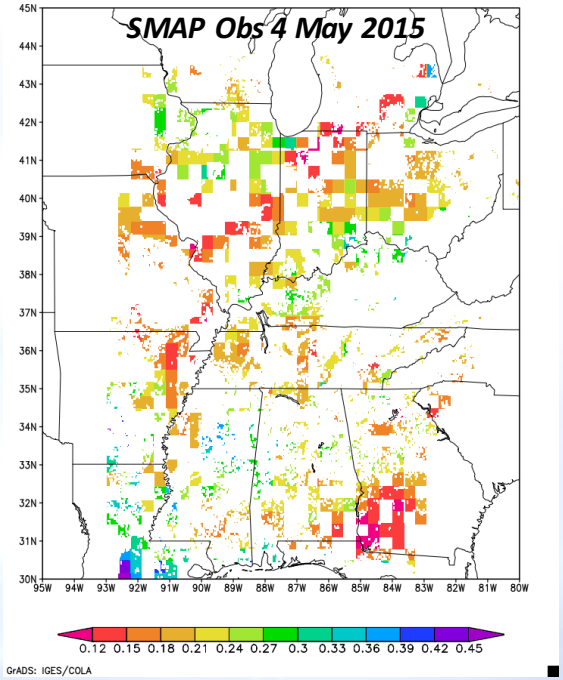
Figure from J. Anderson, NCAR.

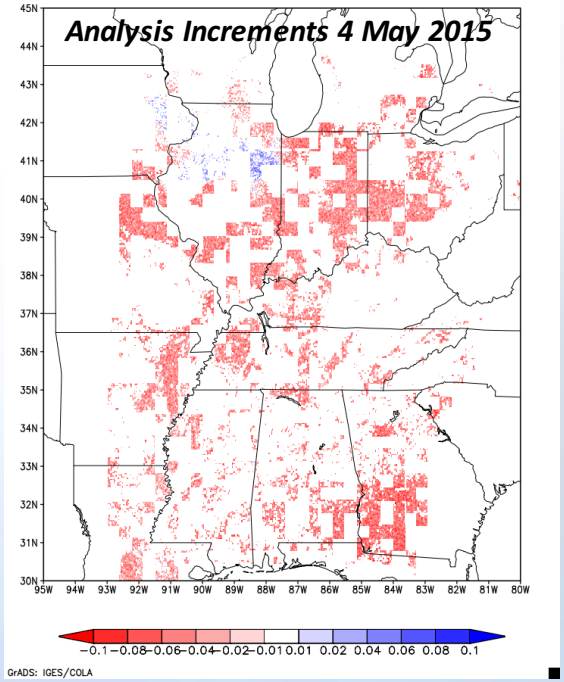
- LIS contains an Ensemble Kalman Filter that can be used to assimilate satellite measurements (e.g., soil moisture, SWE)
- Combines Background (Model) and Observations (Satellite Retrievals), weighted by their uncertainties, to provide a new analysis
- For soil moisture, observation operator relates the top model layer of soil moisture (0-10 cm) to the bias-corrected observations (~5 cm)
- Assimilation of soil moisture during 2nd LIS restart expected to give more representative LSM soil moisture fields to provide improve deeper layers through drainage and diffusion

SMAP L2 Data Assimilation

- Initial results for SMAP L2 data assimilation using the LIS EnKF are shown
- Specifics on observation handling and bias-correction methodology of SMOS data assimilation used for SMAP outlined in a paper currently in review
- Once validation activities are complete later this spring, we plan to incorporate into real-time SPoRT LIS product for situational awareness and model initialization

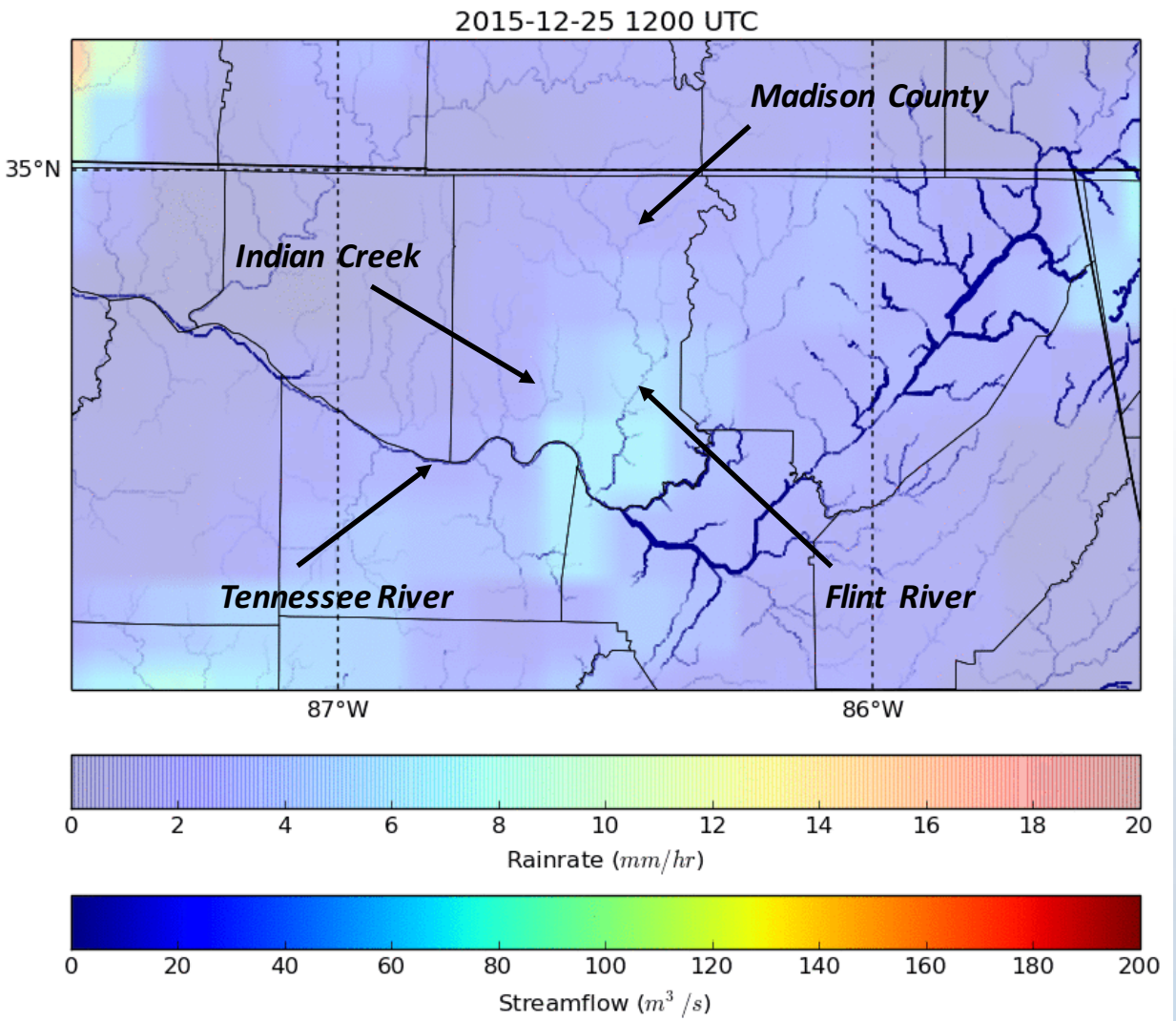






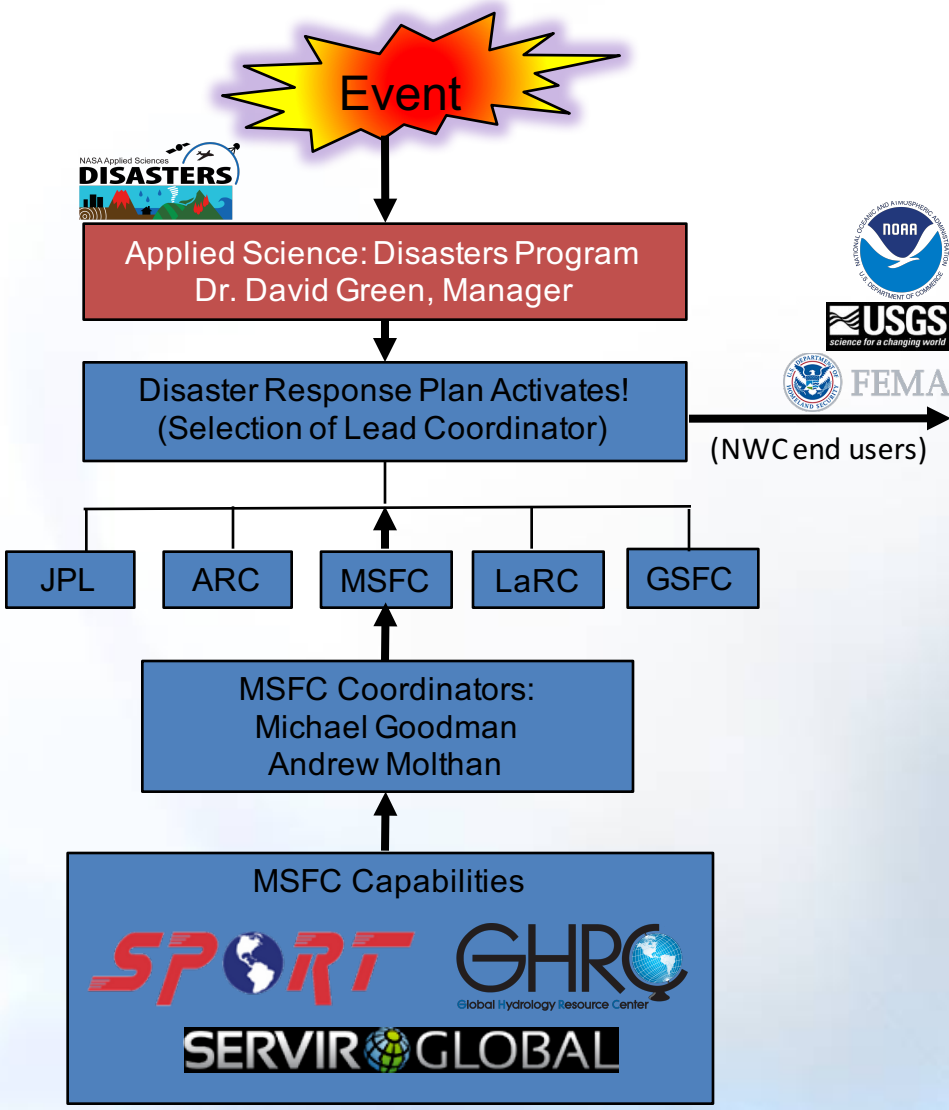
WRF-Hydro Using NASA LIS

- **Christmas Day flood in Madison County, AL**
- **"Cold start" WRF-Hydro**
  - Using NWM namelist for Noah-MP and WRF-Hydro
  - SPoRT-LIS (soil moisture, soil temperature, GVF, and skin temperature)
  - Rain Rate from NLDAS-2
- **Next steps:**
  - Warm/Hot initializations following NWM methodologies
  - Integration of High Resolution Rapid Refresh (HRRR) precipitation forecasts
  - Comparing control, LIS, and LIS + DA runs to understand LSM impacts



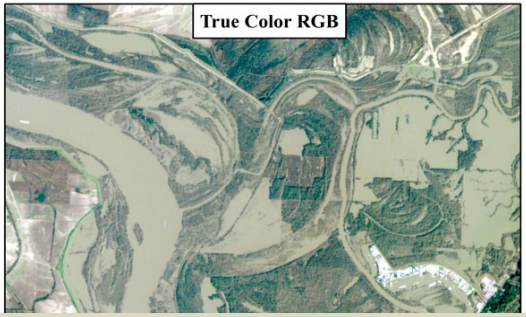
GeoIntelligence and Disasters

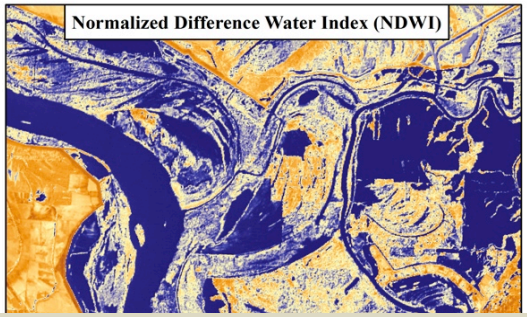
- **The NWC building is envisioned as an operations coordination center for prediction of and response to floods**
- **NASA has an agency-wide Disaster Response Team that compiles and disseminates NASA imagery and products to support operational agencies**
  - Identify the availability of NASA assets (e.g., overpass dates/times of satellites)
  - Use Web Mapping Service (WMS) interface to directly connect users to GIS-formatted NASA observations and products
- **MSFC has partnered with USGS to disseminate NASA data through their Earth Explorer Data Portal**
- **MSFC has capabilities to act as a NASA data portal that would allow direct interfacing with end-users**



Value-Added High-Resolution Products

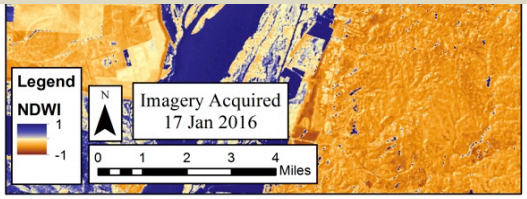
EO-1 imagery for late 2015 Mississippi River flooding near Vicksburg, MS





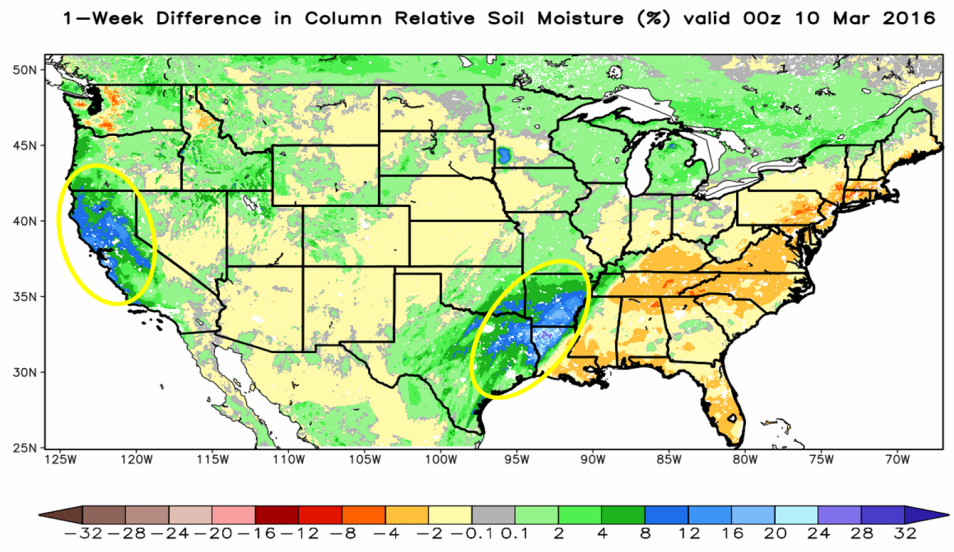
"As I mentioned already, the NDWI product you sent on day 1 conveyed a world of possibilities for us that we have never tapped."

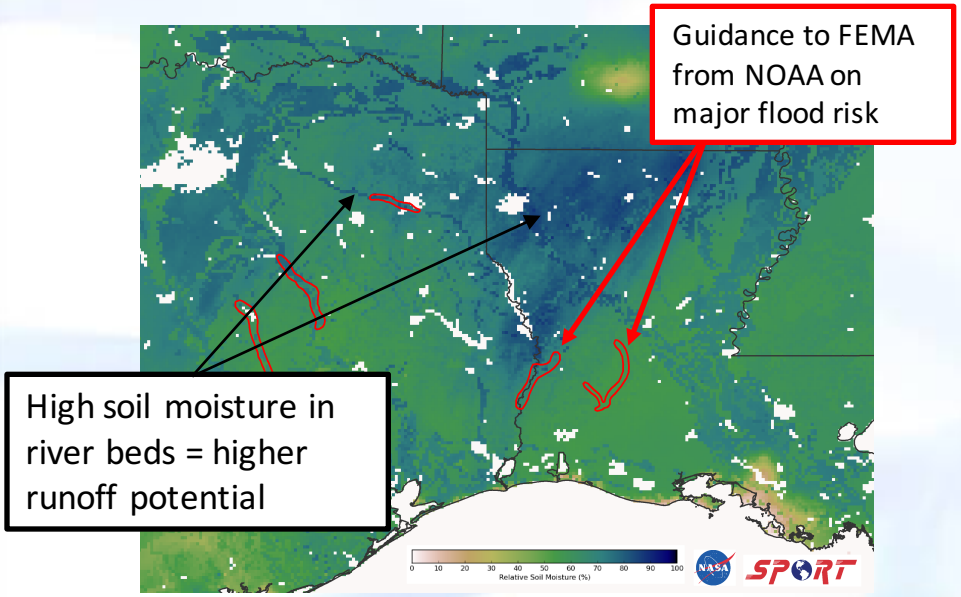
-- Mr. Glen Russell, Remote Sensing Coordinator, FEMA



- **SPoRT produces true color and Normalized Difference Water Index (NDWI) imagery for flood response; transitioned to FEMA using USGS Data Portal**
- **Training and data integration provided to FEMA via email and "Remote Sensing Tiger Team" participation**
- **Allows decision makers from NOAA, USGS, and FEMA to interrogate NASA datasets for disaster response**

Soil Moisture Products for TX/LA





- Support provided for response to flooding in Texas and Louisiana in early March
- SPoRT-LIS real-time, high-resolution soil moisture products helped to show flood potential in the lead-up to and during the event
- Surface soil moisture one-week change product (upper left) shows > 35% change; consistent with October Flooding in SC
- SPoRT-LIS data has been provided to FEMA and USGS using WMS capabilities (lower left); discussions on formal transition ongoing

Summary

- NASA SPoRT generates real-time, high-resolution land surface data from the NASA LIS for use as a situational awareness and model initialization tool in support of local forecasters within the NOAA/NWS
- SPoRT has used the LIS EnKF data assimilation system to assimilate satellite-based soil moisture observations from SMOS and SMAP
- *SPoRT is planning to develop an offline, pseudo-operational version of the National Water Model in collaboration with modelers at the NWC that would allow NASA Applied Science PIs to testbed their NASA-funded research*
- NASA SPoRT has leveraged its research to operations paradigm to support Disaster Applied Science activities by transitioning high-resolution satellite imagery and value-added derived products to operational end-users (e.g., NOAA, FEMA, and USGS) for flood disaster applications
- *As part of the NASA Disaster Response Team, MSFC and SPoRT are available to aid other groups within NASA with data transition, training, and assessment with operational disaster response agencies*

Questions/Discussion

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